BC Environment

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**Ministry of Environment, Lands and Parks**
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B.C. Environment has been conducting a broad survey to monitor concentrations of organochlorine (OC) pollutants in the B.C. environment. Organochlorine is a general term for pollutants such as chlorinated pesticides (ie. DDT, Dieldrin), polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs).

This paper reports on the findings of a small portion of the B.C. Environment's "Phase 2 Dioxin Plan." It contains concentration data of these OCs in the fat or blubber taken from stranded carcasses of mammals found in various locations in the Strait of Georgia. They include one killer whale and seven Harbour Porpoises. These and other marine mammals are known to accumulate various OCs mainly in their fat layers. Since these mammals are at or near the top of the food chain in the marine environment, they are recognized by environmental scientists as important geographic and temporal indicators of OC contamination in our environment.

For example, over the period 1974 to 1982, scientists have measured a significant decrease in the presence of DDT in east coast grey seals – a pesticide not commonly used since the late 1960s.(Addison et al 1984) Likewise Polar bears, which feed almost exclusively on seals, showed the lowest levels of OCs in the high arctic region but the highest OCs in the most southern Hudson Bay region. This finding reflects the relative isolation of the high Arctic mammals from North American sources of contamination.(Norstrom et al 1988)

The fat samples used to test for dioxin and the other OC determination were taken from eight marine mammal carcasses found in the Strait of Georgia: one 56-year-old Killer Whale cow and seven Harbour Porpoises, including three adult males, two adult females, one yearling female and one newborn calf. These stranded mammals were found in various locations in the Strait of Georgia from Johnstone Strait in the north to Victoria in the south (see Table 1).

Dr. Ken Langelier and his co-workers Robin Baird and Pam Stacey are members of a group called Stranded Whale and Dolphin Program of B.C. They were responsible for locating and supplying the Ministry with fat samples from these stranded animals.

Seakem Analytical Services Ltd. of Victoria, B.C. conducted the analyses for OCs testing for a series of common pesticides and their metabolites (or environmental breakdown products), PCBs, coplanar PCBs, dioxins and furans.

Seakem carried out standard extraction and concentration techniques, followed by quantitative and qualitative analysis using state-of-the-art gas chromatography/mass spectrometry (GC/MS) methods. These techniques allow a complex mixture of OC pollutants to be quantitatively separated into individual compounds using the GC method.

Then, the compounds can be confirmed and positively identified using the MS method, which produces a recognizable "fingerprint" for each compound.

The samples were analyzed for twenty-two different OC pesticides, including Mirex, Heptachlor, Nonachlor, chlordane, DDT, Dieldrin, Endrin, Methoxychlor, hexachlorobenzene, and the various isomers, metabolites or environmental degradation products of these OCs. The samples were then analyzed for forty-three different polychlorinated biphenyl (PCBs) congeners and seventeen polychlorinated ibenzo-p-dioxin (PCDDs) and polychlorinatedibenzofurans (PCDFs) congeners. Of these, 2,3,7,8 - TCDD (tetrachlorodibenzo-p-dioxin) is considered the most toxic and the standard against which all other PCDDs and PCDFs are compared in terms of Toxicity Equivalent Factors (TEFs) (see Table 1). The sixteen other dioxin and furan congeners are one-half to one-thousandth as toxic as 2,3,7,8 TCDD. The TEFs therefore range from from 0.5 to 0.001. The summary statistic 2,3,7,8 TCDD-TEQs is derived by multiplying the concentration of a specific congener by the appropriate TEF and summing the products.

Table 1 (next page) lists the eight marine mammals tested versus the concentration of OCs determined in their fat. Note that the concentration values are in parts per million (ppm) for the total pesticides, total DDT and total PCBs. DDT and its metabolites and degradation products are considered pesticides but reported separately here. The total pesticide values include total DDT. The concentration values for the dioxins/furans and co-planar PCBs are in parts per trillion (ppt). A part per trillion corresponds to the number of picograms of OC per gram of wet fat (a picogram = $1x10^{-12}$ gram) whereas a part per million corresponds to the number of micrograms (a microgram = $1x10^{-6}$ gram). Keep in mind that one ppt is one million times smaller than one ppm.

Co-planar PCBs, a small subset of PCBs, are only found at the very low parts per trillion (pg/g) range but are thought to be much more highly toxic.

**Table Legend**

a. the symbol $\Sigma$ means the total concentrations of all compounds in that class
b. the sum, in 2,3,7,8 TCDD toxicity equivalents (TEQs) of the dioxins and furans (See page 3 for details).
c. ND = not detected
d. number in parenthesis indicates a specific PCB compound
e. $\Sigma$PCB measured as Aroclor 1254/1260
f. pesticides detected include: HCB, Aldrin, o'p'-DDE, trans-Nonachlor, p'p'-DDE, Mirex, alpha-BHC, beta-BHC, gamma-BHC, Oxychlordane, Transchlordane, cis-Chlordane, o'p'-DDD, p'p'-DDD, cis-Nonachlor, p'p'-DDT, Heptachlor epoxide, alpha-Endosulphan, Dieldrin, Endrin, Methoxychlor

*Table 1*

## Concentration of Organochlorine Pollutants

**(See Legend, previous page)**

| Species/Location/Sex | Parts per Million[a] | | | Parts per Trillion | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Σ Pesticides[f] | Σ DDTs | Σ PCB | Co-planar PCBs | Σ Dioxins (PCDDs) | Σ Furans (PCDFs) | Σ 2,3,7,8 TCDD-TEQ[6] | 2,3,7,8 - TCDD | 2,3,7,8 - TCDF |
| Harbour Porpoise<br>Gabriola Is. (new calf) | 10.1 | 5.8 | 15.0[e] | ND[c] | ND | 72 | 4.4 | ND | ND |
| Harbour Porpoise<br>Tsawassen (adult male) | 16.1 | 9.4 | 17.0 | ND | 32.8 | 314.8 | 3.6 | ND | 19 |
| Harbour Porpoise<br>Victoria (adult male) | 4.2 | 3.1 | 3.7 | 60<br>(77)[c] | ND | 30.6 | 1.1 | ND | 5.2 |
| Harbour Porpoise<br>Qualicum River (adult male) | 8.2 | 3.9 | 7.7 | ND | 17 | 110 | 8.2 | ND | 45 |
| Harbour Porpoise<br>Hornby Island (1 yr. female) | | | | ND | 16 | 36 | 5.2 | ND | 18 |
| Harbour Porpoise<br>Gabriola Is. (adult female) | 1.2 | 0.7 | 2.8 | ND | 55.7 | 7.8 | 6.0 | ND | 4.4 |
| Harbour Porpoise<br>Qualicum Beach (adult female) | | | | | 87.3 | 49.1 | 22.2 | 3.3 | 44 |
| Killer Whale<br>Johnstone Strait<br>(56-year-old cow) | 13.9 | 8.0 | 13.0 | 180(97)[d]<br>180(126)<br>130(169) | 80.9 | 79.8 | 19.7 | 2.3 | 68 |

With such a small sampling of animals, it is difficult to draw conclusions regarding sources of local geographic contamination in B.C. waters, but comparisons can be made of OC contamination in previous studies of marine mammals in various Canadian marine environments including the Strait of Georgia in B.C.

Recently, environmental scientists from the Department of Fisheries and Oceans and from Canadian Wildlife Services have analyzed for OC contamination in over 170 marine mammals whose locations range from the Arctic regions to the Strait of Georgia and the Gulf of St. Lawrence. The mammals include Arctic Ringed Seal, Narwhal, Beluga, Dolphin, Pilot Whale, Killer Whale, False Killer Whale and Polar Bear.(Muir et al 1990)

Table 2 compares the ranges of concentration for total DDT, total PCBs, the specific dioxin 2,3,7,8 - TCDD, and specific furan 2,3,7,8 - TCDF in these various species with the concentration ranges found in our seven Harbour porpoises and one Killer Whale from this present study. The ranges of DDTs and PCBs in this study are larger in general than for Arctic mammals (bear, seal and beluga) but significantly less than that found in eleven beluga whales in the St. Lawrence estuary where average DDT and PCB levels in these mammals were 96 ppm and 85 ppm, respectively. Also previous studies on six Killer Whales and two False Killer Whales from the Strait of Georgia showed significantly higher DDT and PCB values than the mammals in this present study.

*Table 2*

## Comparison of OC Ranges (Table 1) with OC Ranges in Other Studies (Muir et al 1990)

| Species/Location/Number of Animals | Parts per Million | | Parts per Trillion | |
|---|---|---|---|---|
| | Σ DDT range | Σ PCB range | 2,3,7,8-TCDD range | 2,3,7,8-TCDF range |
| Polar Bear/North Baffin Is. to Hudson Bay/67 | 0.21 to 1.19 ppm | 3.24 to 8.02 ppm | 2 to 20 ppt | <2 ppt (detection limit) |
| Ringed Seal/Cumberland Sound to Barrow Strait/34 | 0.14 to 1.10 | 0.28 to 0.83 | 8 to 37 | 3 to 4 |
| Beluga/Baffin Bay to St. Lawrence estuary/25 | 1.6 to 152 | 2 to 148 | <2 (Aug.) | <2 (Aug.) |
| Killer Whale/Strait of Georgia to Vancouver Is./6 | <1 to 102 | 2 to 60 | <2 (Aug.) | 19 (Aug.) |
| False Killer Whale/Strait of Georgia to Vancouver Is./2 | 76 and 1920 | 45 and 34 | <2 and 8 | 2 and 109 |
| *from Table 1* Harbour Porpoise/Strait of Georgia/7 | 0.7 to 9.4 | 2.9 to 17.0 | <2 to 3.3 | <2 to 45 |
| *from Table 1* Killer Whale/Johnstone Strait/56-year-old cow/1 | 8.0 | 13.0 | 2.3 | 68 |

Polychlorinated dioxins and furans were found in almost all blubber samples in our study, however, the most toxic dioxin, 2,3,7,8 - TCDD, was not detected in six of the porpoises and was close to detection level in the other porpoise and whale at 3.3 ppt and 2.3 ppt, respectively. However, the more prevalent, but less toxic furan, 2,3,7,8 - TCDF was detected and ranged from < 2 to 45 ppt in porpoise blubber and was 68 ppt in the older Killer Whale's blubber. These dioxin/furan levels are similar to those found elsewhere in marine mammals (see Table 2) but are significantly less than those found in the livers of crab and bottom fish taken from waters adjacent to the Strait of Georgia pulp mill sites. For example, within the Powell River closure area the range of dioxin/furan (as measured in 2,3,7,8 - TCDD - TEQs) for Dungeness crab (liver) is 32 to 174 ppt. (ref 4) The TEQs for bottom fish (liver) is 17 to 35 ppt. The average for our seven porpoises is 7.2 ppt and for the Killer Whale Cow - 19.7(Harding et al 1990)

It must be kept in mind that it is difficult to make comparisons between mammals and fish/invertebrates due to variability in metabolism and uptake of various OC pollutants, differences in food chain or proximity to source of pollution.

In summary, we find the general level of OC contamination in the mammals in this small group is less that that found in mammals from the more highly populated eastern regions around the St. Lawrence estuary. Higher levels of OCs were found in these marine mammals from the Strait of Georgia than have been found in similar marine mammals from Arctic regions. The seven porpoises and one Killer Whale also have high concentrations of 2,3,7,8-TCDF, a furan common to pulp mill effluent, but concentrations of 2,3,7,8-TCDD were low, close to the detection levels.

The data presented here is only a small piece of the total picture of OC contamination in our Strait of Georgia environment. Due to the small sample size, no definitive conclusions can be drawn. More research and testing is clearly needed.

1. Addison, R.F., P.F. Brodie, M.E. Zurich and D.E. Sargeant. (1984). Environmental Science & Technology 18 935-937.

2. Norstrom, R.J., M. Simon, D.C.G. Muir, and R.E. Schweinsburg. (1988). Enviromental Science & Technology 22 1063-1071.

3. Muir, D.C.G. and R.J. Norstrom, paper presented 17th Annual Aquatic Toxicity Workshop, Marine Environmental Quality Monitoring session, Nov 5 (1990).

4. Harding, L. E. and W. M. Pomeroy, "Dioxin and Furan Levels in Sediments, Fish, and Invertebrates from Fishery Closure Areas of Coastal British Columbia" Environment Canada. Regional Data Report 90-09. July (1990).